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Students' Mathematics Problem Solving Skills between Full-Online Learning and Hybrid Learning in Statistics Course

Tanti Listiani
Universitas Pelita Harapan, Indonesia, https://orcid.org/0000-0003-2170-3680

Abstract: Learning loss due to online learning has caused students to experience a decrease in their ability to solve mathematical problems. One of the declines in students' mathematical problem-solving skills occurred in the statistics course. Statistics as a branch of mathematics has an important role in training students' skills in processing and analyzing data. The low ability of students to solve mathematical problems became a serious problem. So we need an appropriate learning model to overcome these problems. One of the learning models that can be used is hybrid learning. The subject of this study was the primary student study program from the Faculty of Education at UPH in Indonesia, with 110 samples divided into 54 control groups and 56 experimental groups. The control class was treated with full online learning, while the experimental class used hybrid learning. This research aimed to compare which type of learning is more effective, full-online or hybrid learning. The research method used in this study is quasi-experimental. Data were processed using SPSS, called the normality test with Shapiro-Wilk, and statistical tests using Mann-Whitney. The results showed that hybrid learning was more effective than full online learning.

Keywords: Student's Mathematics Problem Solving Skills, Full-Online Learning, Hybrid Learning, Statistics Course, Learning Loss.

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Introduction

Statistics is a science commonly used to collect, process (analyze), and conclude data in the form of numbers (Yulianti et al., 2022). At UPH FIP, students usually take statistics courses with the hope that they will equip them with practice skills in collecting data, analyzing it, and drawing conclusions. Statistics is an important subject to study because it contains many things related to everyday life (Nisa & Setianingsih, 2019). Of course, prospective teachers and researchers can also feel the benefits of statistics, such as when presenting data, processing data, analyzing data, and concluding the data.

Since understanding statistics is essential, prospective teacher students at UPH FIP are required to take this

course. However, issues arise when students attempt to solve various statistical problems. Students are often confused when they finish problems that differ from the examples. It shows that students have low mathematical problem-solving abilities. Problems also arise when students work on mini-research projects. They often do not work according to the stages taught, while statistics require systematic work according to the stages that have been taught. Low problem-solving abilities can impact student learning outcomes (Endah et al., 2019). Students need to have mathematical problem-solving skills. When solving mathematical problems, it is demonstrated that many students are still oriented toward the final result (Resmiati & Hamdan, 2019). When solving problems, people tend to directly use memorized formulas without systematically describing the solution. The low ability to solve mathematical problems can also be shown by procedural errors, where the error does not pay attention to the steps of solving the problem and does not consider the process of solving the problem important because it feels that several solving steps are not needed to be explained completely and systematically (Ruswati et al., 2018).

Difficulties in solving mathematical problems can also be seen when given problems in the form of word problems, the difficulty encountered is modeling in the mathematical form, which results in difficulty in determining formulas. Even the most important thing in problem-solving is how to change the mindset so that you can analyze what concepts are contained in the problem, and think about the steps for solving it so that it can then be poured into the form of ideas or mathematical symbols, and then the solution can be determined step by step (Senjayawati, 2015). The problems of UPH FIP students were also seen when determining hypotheses, they often did not write them down because they were deemed unnecessary, and students preferred to determine formulas without following the stages of statistical research.

Students need to have the ability to solve mathematical problems because this ability is needed to develop students' cognitive abilities (Rahmwati et al., 2022). Problem-solving is the basis for honing higher-order thinking skills, which aim to explore students' skills, innovation, and knowledge in solving a problem (Arigiyati & Istiqomah, 2016). Students become unfamiliar with new types of questions as a result of a learning process that does not emphasize problem-solving questions; they will find it difficult and confusing to answer questions that, in the end, answer questions at random (Adhyan & Sutirna, 2022). Such student habits can result in low mathematical problem-solving abilities, even though problem-solving abilities are the basic goal of learning mathematics (Sumartini, 2016).

Statistics is a branch of mathematics, while mathematics requires problem-solving skills. Problems arise because of possible learning loss in students. Learning loss occurs among students and is a serious problem (Patrinos & Donnelly, 2021; Puslitjak, 2021). Learning loss can be seen in the lack of students' mathematical problem-solving abilities. Learning loss conditions can occur for two reasons, due to long holidays and because learning that is normally carried out is changed using a new system (Lim et al., 2022). Thankfully, towards the middle of this year, the delta variant virus mutated into the omicron variant, and this omicron variant has reduced cases of death (NEJM, 2022).

Knowing that the ability to solve mathematical problems is important for students to have, the best solution is needed. Grateful that the current conditions have improved. So that learning, which was originally carried out in full online, can be adapted to a better method. One method that can be used is hybrid learning. Hybrid learning is a learning method that is the best choice today (Ganovia et al., 2022; Gleason & Greenhow, 2017). The use of hybrid learning is said to have a positive impact on learning. Through this learning, students can feel the relationship with lecturers and friends directly, even though some parts are still carried out online. The results of the study suggest that learning that is carried out in full online is less effective due to the lack of facilities and infrastructure and the unpreparedness of technology education (Dwi et al., 2020). In this study, we will see a comparison of full-online learning with hybrid learning on students' mathematical problem-solving abilities. The aim is to see which learning method is more effectively used to overcome students' mathematical problem-solving problems. The question posed by this research is whether the use of hybrid learning is more effective than full online learning.

Method

The research method used is quasi-experimental research with non-parametric statistics, where the control class used is the class that is taught in full-online learning while the experimental class is subjected to hybrid learning. A quasi-experimental design is a form of experimental design developed from a true experimental design. This design has a control group, but cannot fully control external variables that affect the implementation of the experiment (Sugiyono, 2010). The subjects of this study were students of the Faculty of Education who took statistics courses. The data analysis technique used was a test using the same scoring rubric but different treatments for the two class groups. The test was carried out using SPSS by testing the normality and homogeneity of the data. If the normality test shows that the data is normally distributed, then the independent t-test can be used. However, if the data is not normal, a Mann-Whitney test can be used. The students who were respondents were students in the elementary school teacher education study program's classes of 2019 and 2020. The class of 2019 consisted of 54 students, while the class of 2020 consisted of 56 students. The research design used was the post-test-only control group design. The post-test-only control group design scheme is shown in Table 1 as follows. According to (Sugiyono, 2014), the research design can be described in the following scheme:

Tabel 1. Post-test-only Control Group Design

Subject	**Treatment**	**Result**
Control Group	Full-Online Learning	Postest (O_1)
Experiment Group	Hybrid Learning	Postest (O_2)

Results

Statistics learning was completed in 16 meetings, with details of 14 learning processes and two examination

meetings. This research was done for two classes that were treated with online learning and hybrid learning. The materials covered several topics, including learning about measurement scales, data distribution, hypothesis testing, one-sample t-tests, two-sample t-tests, and mini-research projects. Students in the 2019 class are treated to full-time online learning. Because of this, conditions in Indonesia were still constrained to face-to-face learning. This is due to the spread of the COVID-19 virus, which has claimed many deaths. Meanwhile, for students in Class 2020, learning is carried out in a hybrid learning. Learning is carried out in a hybrid manner because conditions in Indonesia have improved due to the COVID-19 virus and because face-to-face and online learning can be combined.

At each meeting, the lecturer gives a test to check the student's ability after studying the material. Additionally, check students' mathematical problem-solving abilities on topics in statistics. The test is structured based on indicators of students' mathematical solving abilities based on Polya's steps. According to Polya, there are four indicators for solving mathematical problems, including understanding the problem, planning a solution, solving the problem according to plan, and checking again (Polya, 1973). This research was based on these four indicators, and the test was given to students as a reference. To see students' mathematical problem-solving abilities, test results are used, which will then be compared based on the topics in the statistics course.

Data from the test results were collected and then recapitulated according to the existing topics. Furthermore, the test scores of students' mathematical problem-solving abilities were processed using inferential statistics. The test results were tested for normality using SPSS, and if they were not normal, they were continued using the Mann-Whitney test. The following are the results of the normality test using the Shapiro-Wilk method:

Table 2. Test of Normality with Shapiro-Wilk

No.	Topic	Tests of Normality with Shapiro-Wilk			
		Control Group		Experiment Group	
		Sig.	Result	Sig.	Result
1	Scale Measurement	<.001	Not Normal	<.001	Not Normal
2	Data Interpretation	<.001	Not Normal	<.001	Not Normal
3	Measure of Dispersion	<.001	Not Normal	0.02	Not Normal
4	Hypothesis Test	0.098	Normal	0.02	Not Normal
5	One Sample t-test	<.001	Not Normal	<.001	Not Normal
6	Independent two-sample t-test	0.001	Not Normal	<.001	Not Normal
7	Dependent t-test	<.001	Not Normal	<.001	Not Normal
8	Mini Research Project	<.001	Not Normal	0.016	Not Normal

Based on Table 2, only the hypothetical test topics in the control group were normally distributed. Other topics in the control and experimental groups are not distributed normally. Because most of the data is not normally distributed, the tests are conducted using non-parametric statistics. The non-parametric statistic used to compare the data of the two samples is Mann-Whitney. The following are test results using Mann-Whitney:

Regarding the presentation of the data and the dependent t-test, Table 3 demonstrates that there is no difference between the experimental class and the control class. For other topics, there is a difference in the average value.

From the average value obtained, criteria for mathematical problem-solving skills of students can also be determined (Japa, 2008). This criteria can be seen in Table 4.

Table 3. Mann-Whitney U Test Results

No.	Topics	Mann-Whitney Test					
		Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig (2-tailed)	p-value	Result
1	Scale Measurement	610.000	2150.000	-5.136	<0.001	<0.05	There is a difference
2	Data Interpretation	1171.500	2711.000	-1.833	0.067	>0.05	No difference
3	Measure of Dispersion	998.000	2594.000	-2.555	0.011	<0.05	There is a difference
4	Hypothesis Test	1029.000	2254.000	-2.085	0.037	<0.05	There is a difference
5	One Sample t-test	736.000	2114.000	-4.369	<0.001	<0.05	There is a difference
6	Independent two-sample t-test	920.500	2246.500	-2.697	0.007	<0.05	There is a difference
7	Dependent t-test	1091.000	2172.000	-0.272	0.786	>0.05	No difference
8	Mini Research Project	1001.000	2771.000	-3.406	<0.001	<0.05	There is a difference

Table 4. Criteria of Test Result

Score	Criteria
85,00-100	Very good
70,00-84,99	Good
55,00-69,99	Average
40,00-54,99	Less
0-39,99	Very less

Table 5 displays the mean difference between the experimental group and the control group.

Table 5. Differences in Means between the Control Group and the Experiment Group

No.	Topics	Mean				Information
		Control Group	Criteria	Experiment Group	Criteria	
1	Scale Measurement	86.42	Very good	97.01	Very good	Control < Experiment
2	Data Interpretation	88.17	Very good	81.32	Good	Control > Experiment
3	Measure of Dispersion	81.25	Good	73.26	Good	Control > Experiment
4	Hypothesis Test	73.47	Good	79.46	Good	Control < Experiment
5	One Sample t-test	77.69	Good	91.92	Very good	Control < Experiment
6	Independent two-sample t-test	71.79	Good	81.84	Good	Control < Experiment
7	Dependent t-test	83.04	Good	82.96	Good	Control > Experiment
8	Mini Research Project	84.50	Good	79.75	Good	Control > Experiment

In Table 5, it can be seen that the mean value of students' mathematical solving abilities in the control group is higher than that in the experimental group on the topics of data presentation, dependent t-test, and mini research project. Other topics showed a higher average value for the experimental group than the control group. When compared to Table 3, the Mann-Whitney test on the topic of data presentation and the topic of the dependent t-test showed no significant difference. So even though there is a difference in the average, statistical tests show no difference in values between the control and experimental groups. From Table 5, it is presented in the form of a diagram as follows:

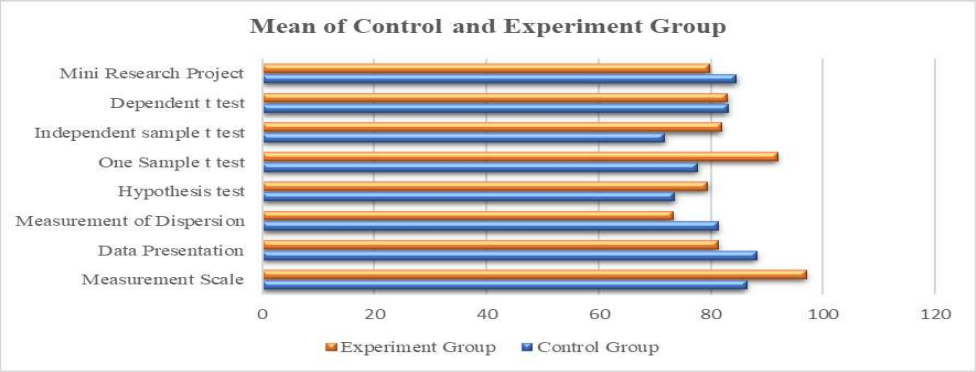


Diagram 1. Comparison of the average Control Group and Experiment Group

Discussion

Comparative testing for the eight topics that were assessed resulted in a variety of findings, which is apparent from the explanation above. The normality test itself indicates that the majority of the data are not dispersed normally. The test is carried through a non-parametric statistical test because the data are not normally distributed. The Mann-Whitney U test is the comparison tool utilized for abnormal data.

The results and the Mann-Whitney U test indicate that there are six topics with a distinct average and two topics where there is a non-significant difference in the average. The two topics that were not significantly different were the topic of presenting statistical data and the dependent t-test. Meanwhile, the 6 topics that differed significantly were: measurement scale, size of data distribution, hypothesis testing, one sample t-test, independent t-test, and mini research project.

On the topic of measurement scales, the average for the control group (full-online learning) was 86.42, while the experimental group (hybrid learning) obtained an average of 97.01. The outcomes of the Mann-Whitney U test reveal that there are variations in how much value individuals place on their capacity to solve mathematical problems related to measurement scales. Students in hybrid learning courses demonstrate superior mathematical problem-solving skills compared to those in fully online courses.

Topic of data presentation, the average value using full-online learning was 88.17, while classes using hybrid

learning obtained an average of 81.32. Data showed that there was no difference in the value of mathematical problem-solving abilities. On the topic of data presentation, classes that used full-online learning better than hybrid learning.

Topic of measurement of dispersion, the average value using full online learning was 81.23, while classes using hybrid learning obtained an average of 73.26. Data showed that there were differences on the topic of measurement of dispersion. Classes that use full-online learning showed better than hybrid learning.

On the topic of hypothesis-test, the average value using full-online learning was 73.47, while classes using hybrid learning had an average of 79.46. Data showed that there were differences. Classes that use full-online learning showed that students' mathematical problem-solving abilities are smaller than those of students who use hybrid learning.

On the one sample t-test topic, the average value using full-online learning was 77.69, while classes using hybrid learning obtained an average of 91.92. Data shows that there are differences on this topic. Classes that use full online learning showed smaller than hybrid learning.

On the topic of the independent two-sample t-test, the average value using full online learning was 71.79, while classes using hybrid learning obtained an average of 81.84. Data shows that there are differences value in this topic. Classes that use full-online learning showed smaller than hybrid learning.

On the dependent t-test topic, the average value of full-online learning was 83.04, while the class using hybrid learning had an average of 82.96. Data showed that there was no difference value on the topic of dependent t-test topic. Although the average for full-online learning is slightly higher than hybrid learning.

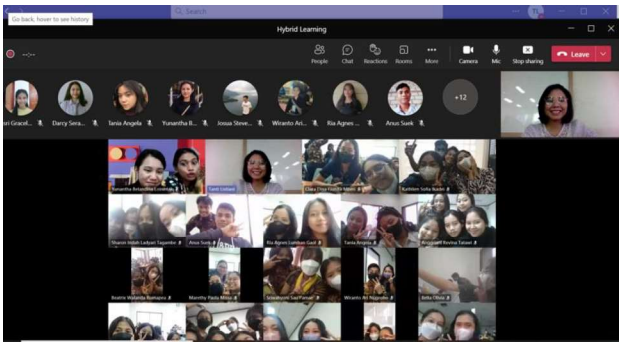
In the mini-research project topic, the average value using full-online learning was 84.5, while classes using hybrid learning obtained an average of 79.75. Data shows that there are differences in the value on the topic of mini-research project. Classes that use full-online learning show greater than hybrid learning.

From the explanation above, it can be seen that of the 8 existing topics, 2 topics have no difference using either hybrid learning or full-online learning. The topics in question are the topic of data presentation and the topic of the dependent t-test. Six other topics showed differences, on the topic of data distribution size and the topic of mini research projects, the value of students' mathematical problem-solving abilities showed better scores with full online learning compared to hybrid learning. Differences were also shown in 4 topics, including the topic of measurement scales, hypothesis-test, one-sample t-tests, and independent sample t-tests. On these topics, students' mathematical problem-solving abilities are better when using hybrid learning than full online learning. So it can be concluded that 2 topics have no differences, 2 topics have differences but were better with full online learning, and 4 topics have differences but hybrid learning shows better results compared to full-online learning. Here, the use of hybrid learning dominates. According to research conducted by (Alsowat, 2022;

Thamrin et al., 2022) hybrid learning provides many advantages. Hybrid learning makes learning more effective because lecturers and students can discuss directly (Rahmat, 2022). Students can also collaborate more easily and minimize mis-communication (Yang et al., 2022).

Even though full-online learning also provides many advantages, students feel bored if they can only stare at the monitor (Gumasing et al., 2022; Nafiah et al., 2021). Full-online learning has weaknesses (Arifuddin et al., 2021; Maulida & Akmal, 2021), including students experiencing a learning loss (Engzell et al., 2021). They were bored because they could stare at the computer screen all day. They felt disturbed by the condition of the surrounding environment. There are limited devices for synchronous and asynchronous sessions. There is the possibility of cheating during exams because lecturers cannot directly supervise the implementation of quizzes or tests. Students are limited to their internet quota. Students really relly on the device, whether the device is slow or not updated with the times. Hybrid learning provides a new color for primary students study program. Students showed an enthusiastic response because they could discuss directly with the lecturer and work on group assignments with their friends. Even though there is a fear of being exposed to the COVID-19 virus, the mandatory vaccine regulated by the state has reduced the serious symptoms of the COVID-19 virus.

Hybrid learning gives a more interesting impression to students. Hybrid learning combines online and traditional learning by taking more effective steps so that learning becomes more meaningful. Even though students save time by undergoing full online learning, they can meet directly with their colleagues during face-to-face sessions in hybrid learning. The following is an example of how hybrid learning is carried out.



Picture 1. Hybrid Learning Photo

In almost every meeting, some students do not attend because they must isolate due to exposure to COVID-19. Of course, this can harm other colleagues who do not have good body immunity. Hybrid learning provides an interesting learning experience for lecturers as teachers and provides many benefits for students.

Conclusion

The results of the study show that the topics taught in statistics courses yield better average scores when using hybrid learning than full-online learning. So, it can be concluded that hybrid learning is more effective than full-online learning. This research still has many weaknesses because it does not explain each indicator of problem-

solving ability. However, researchers will try to make subsequent articles that discuss each indicator on each topic taught in this statistics course in more detail. Full-online learning has its own advantages and disadvantages. Instead of replacing in-person instruction, online learning serves as a tool that instructors and students can use to supplement it. By utilizing both learning environments, the hybrid learning method can be a solution for students who need to learn as much as possible. With this method, students can enhance their knowledge and access tools, which will enhance their learning.

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